EXPLANATION OF CUTS OF CRANIA OF ANURA.

The numbers in each column correspond with the types of ossification mentioned in the text, and are the same as those in the table of families given in the same connection. The power numbers attached to Fig. 3, represent the degree of ossification of the nasal bones, except the —1, which signifies unossified ethmoid. Most of the cuts are original.

BUFONIDÆ.—Fig. 2, anterior part of skull of *Chelydobatrachus gouldi* Gray, from Australia. Fig. 3, do of *Schismaderma carens* Smith, S. Africa. Fig. 6, top of head of *Peltaphryne peltacephala* D. and B., Cuba. Fig. 7, top of head of *Otaspis empusa* Cope, Cuba.

SCAPHIOPIDÆ AND PELOBATIDÆ.—Fig. 2, diagram of top of cranium of *Didocus calcaratus* Micahelles, Spain. Fig. 5, skull of *Scaphiopus holbrooki* Harl., United States. Fig. 6, skull of *Cultripes provincialis*, from France, after Dugès.

HYLIDÆ.—Fig. 1, *Thoropa misiessi* Bibr., Brazil. Fig, 2, *Hypsiboas doumerci* D. and B., Surinam. Fig. 2^1, *Hypsiboas punctatus* Schn., Brazil. Fig. 3^2, *Scytopis venulosus* Daudin, Brazil. Fig. 6, *Trachycephalus geographicus* D. and B., Brazil, after Steindachner.

CYSTIGNATHIDÆ.—Fig. 1, *Eusophus nebulosus* Gir., Chili. Fig. 2, *Borborocœtes tasmaniensis* Gthr., Tasmania. Fig. 3, *Elosia nasus* Licht., Brazil. Fig. 3^3, *Hylodes oxyrhynchus* D. and B., W. Indies. Fig. 4, *Grypiscus umbrinus* Cope, Brazil. Fig. 6, *Calyptocephalus gayi* D. & B., Chili.

RANIDÆ.—Fig. 3^1, *Ranula chrysoprasina* Cope, Costa Rica. Fig. 3, *Rana oxyrhyncha* Sund., S. Africa. Fig. 3^1, *Rana clamitans* Daud., N. America. Fig. 3^2, *Rana agilis* Mus., Berol. Fig. 3^3, *Rana hexadactyla* Less., India. Fig. 4, *Polypedates quadrilineatus* D. and B., Ceylon.

[*To be Continued.*]

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CONCERNING AMBER.[1]

BY ERMINNIE A. SMITH.

THE history of amber illustrates most clearly not only the slow and tedious growth of civilization, but also the seeming perversity and obtuseness of human nature, which, especially in former times, so retarded the advancement of science. Exhuming this history from the dim, far distant, prehistoric past, we find that from being first used for fuel by the almost barbaric northern hordes, among the more refined southern peoples, amber, like bronzes and their other articles of luxury, took the place of coin and had its economical and financial import. The oldest written documents that have come to us, mention it as one of the chief articles of luxury of the ancient civilized world, an object of greater request than fine gold.

[1] Read before the "American Asso. for the Advancement of Science," at Saratoga, August, 1879.

Three thousand years ago it was well known among the inhabitants of Hellas that amber would attract light bodies, and Thales, one of the "seven wise men of Greece," adduced that circumstance in support of his theory that inanimate objects possessed souls, but two and a-half thousand years passed before it was discovered that it was this self-same power which, flashing amid the roar of thunder, illuminated the wide canopy of Heaven, bound iron to iron and directed the silently recurring course of the magnetic needle.

Tamed and chained as we have considered this all-pervading element, still, as day by day we are startled by new discoveries, and while awaiting the result of investigations which may transform the night of our great metropolis into day, are we not as puzzled that these problems should have remained so long unsolved as astonished at their solution?

Americans can complacently pardon the inexplicable fact that Dr. Wall, the English scientist, when succeeding in drawing the electric spark from amber and hearing the crackling sound accompanying it, compared the two to thunder and lightning, but left the discovery of their being identical to our Benjamin Franklin, with his kite and key.

Although nearly two thousand years ago, Pliny wrote that amber was the fossil resin of the extinct Conifer, *Succinum pinites*, to-day the subject presents many unsolved problems. It is true the modern geological column has assigned it an approximate geological place, and modern chemistry has given it a formula, and its principal scientific value as the source of succinic acid and varnish.

A brief review of some established facts in regard to amber as also some of the erroneous but popularly received ideas, which, if unimportant, still remain uncorrected, will perhaps show that for a substance ever popular, coveted as a luxury, even ranking as a gem, both useful and ornamental, with a name in every language expressive of its many qualities, it has scarcely received the attention it deserves.

Probably the oldest of these names is *bernstein*, or its equivalent in the old Teutonic, from its combustibility. Its two Latin names are *succinum* (juice) and *lincurium*. In Persian it is called *körnbu*, or straw robber; in French the trivial name is also *tire de paille*, from its attracting straw; in Italian, Spanish and English

nearly the same name is given for amber, signifying cluster or mass. The first Greek name applied to it was a term signifying the rays of the sun, either from the color or some relation to the sun god. The popular Greek name was *electron*, or the attractor, and thus our substance can boast of having added a word to nearly every language, as even the mother-tongue-loving Germans find *electrität* more euphonious than their harsher synonym, *bernsteinkräftigungrüstzeug*.

Italy, Spain, France, Switzerland and England are given as amber-producing countries, but it must not be forgotten that under this name are included many fossil resins, the differences in which have as yet been hardly determined. In Lemburg, in the Tertiary sandstone, with giant oysters, a splendid amber is found in immensely large pieces, clearer than the Prussian, and producing a most delightful odor when burnt.

In the pitch coal of Bohemia, Reutz found specimens containing sulphur, and also with the foraminifera of the Vienna Tertiary. Daubré found amber in Alsace, and Schubert in the Alps, but these were of a different quality from that of the Baltic sea. But there is no doubt that this amber conifer forest reached from Holland over the German coast, through Siberia and Kamtschatka even to North America, and from the abundance of amber found in some localities, those conifers must have been as productive as is at present the *Dammara australis* of New Zealand, the twigs and branches of which are so laden with white resin as to have the appearance of being covered with icicles.

One of the great deposits of amber is in the Hauptvaterland, where on the plains of Pomerania the peasants dig in the surface clay for it. In the vicinity of Brandenburg, pieces have been found weighing four pounds.

From this abundance of amber in the drift clay and also from the fact that branches of "arbor vitæ" *(Thuja occidentalis)* occur in the Baltic amber, and have been found in the stomach of the mastodon in the United States, Göppert concluded that the "Diluvial," or time of the mammoth in the old world and mastodon in the new, was the age of amber.

This theory has since been entirely disproved.

By far the most celebrated locality for its richness in amber, and one which still possesses great stores of this valuable fossil, is the peninsula of Samland—a portion of Prussia nearly surrounded by the Baltic sea.

The northern part of this region, which constitutes the promontory of Brüsterort, is very hilly, and the coast banks are often from one hundred and fifty to three hundred feet high. Formerly this was all owned and worked by the German government, and was watched by *gens d'armes;* all amber found, even by the peasants in ploughing, being claimed, the finder, however, receiving one-tenth of its value. For the piece in the Berlin Museum, weighing eighteen pounds, the finder received a thousand dollars.

Until ten years ago, during stormy weather, when the waves were beaten against the banks of this coast, the amber was thrown up in quantities, entangled in the seaweeds, and a hundred hands were ever ready to intercept it with their nets, a trying occupation, as the roughest storms yielded the richest booty. Of late years the diving apparatus has been used so successfully that the marine deposit has been greatly diminished, and systematic mining is now carried on inland, where the amber is much finer.

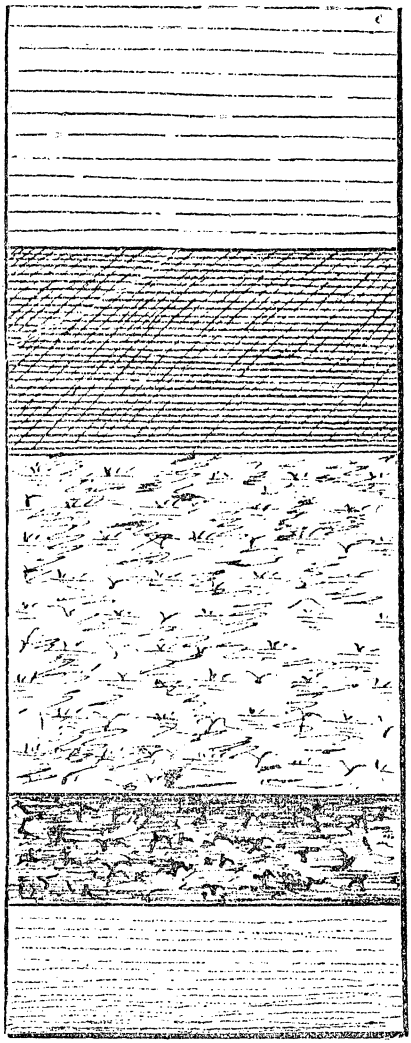
The price of amber has increased during the last year, and this advance is caused by the diminution of the yearly product, many of the pächters, or renters, having thrown up their contracts and abandoned the business of mining on that account.

It was in this famed locality of Samland, so favorable for geological survey that Prof. Zaddach of the University of Königsburg, pursued his investigations relating to the birthplace of amber, and his report throws great light upon this vexed question.

Taking a section of the cliffs where the geological structure is exposed, he finds that wherever the Tertiary formation crops out, it always comprises two different deposits. The underlying consisting of thick beds of glauconitic sand, which sometimes attains a height of sixty feet above the sea level, and upon this rest the beds of the Brown Coal formation, from sixty to a hundred feet thick. Under the green sand lies the so-called amber earth, only from four to six feet thick, and underneath this the "Wilde Erde," so called because containing no amber.

Sometimes the beds of green sand are cemented by hydrated oxyd of iron into a coarse sandstone which often contains well-preserved fossils representing the Tertiary period, but as this glauconitic sand is a marine formation, it follows that the amber it contains does not lie in its original bed—that is, not in the soil of the old forest in which the amber pines grew—but that the amber was washed into the sea in which sea urchins and crabs lived.

In the sand of the amber beds are found numerous pebbles or pieces of compact stone, which is evidently the parent rock of the green sand, as it is composed of exactly similar granules of



GEOLOGICAL SECTION OF THE AMBER COAST OF SAMLAND.

quartz bound together by a marly cement. The amber earth also abounds in fragments of rock known as chalk marl, which contain Cretaceous fossils.

The same rock is found on the Island of Bornholm in the Bal-

tic, and belongs to the Cretaceous. It is therefore proved that the Tertiary glauconitic sand has been made up of the green sand of the Cretaceous formation. Therefore the trees yielding the amber resin must have grown upon the green sand beds of the Cretaceous which then formed the shores of the estuary where the lower division of the Tertiary accumulated. Zaddach assumes that at that time the coast sank slowly, and the forest soil being washed by the waves the amber was carried into the sea.

Immediately over these amber-producing strata rest the beds of the Brown Coal formation, the fossil plants of which differ entirely from the amber flora. Finally, Prussia was laid dry by an upheaval of the rocks, and this ended for a time the recorded history of the country.

Now ensued a new period in the geological history of Samland, when the climate and all the conditions of the country were changed. The mountains of the north which projected out of the sea were covered with glaciers that extended down to the water.

Icebergs laden with the finer débris of rocks and blocks of stone, were detached from these glaciers and drifted to the south, passing over land formed of Cretaceous strata. Without doubt there remained a considerable deposit of amber upon this green sand bed of the Cretaceous formation where the old forest soil still existed. By the icebergs this soil was now broken up and the amber brought down and scattered in every direction.

Thus the fact is explained that amber nests are found in the quaternary deposits over all the plains of northern Europe.

This epitome of Prof. Zaddach's report seems to settle the question as to the birthplace of amber in Germany, and contradicts entirely the generally received opinion that it is the product of the Brown Coal formation, and also the theory of Dr. Feuchtwänger, that marine amber was a later deposit or formation than terrestrial.

It is apparent that the gum of the amber trees flowed out as a viscid sap to which all small objects, leaves, twigs, insects, etc., that came in contact with it adhered. Subsequent exudation covered these and preserved them more perfectly than was possible by any other method. In this way vast numbers of insects were hermetically sealed up, over eight hundred species having been discovered and many groups yet remaining to be studied.

These give us much interesting information in regard not only

to the insect life of the amber age, but afford valuable information in regard to the history of many of our living species and groups (see Heer's description of amber insects). These species are now mostly extinct but have affinity with tropical forms. A very interesting collection of these most ancient mummies can be seen in the British Museum. A classic spider is at Amherst, and in my own collection is a lizard so perfectly embalmed that the animal tissues can be seen, as also the liquid contained in the stomach; this little curio has the honor of having been christened by Prof. Agassiz.

Prof. H. R. Goeppert has made a study of the remains of plants found in amber, and has identified one hundred and sixty-three species, all of which are now extinct. Mr. Kaldenberg, of New York, has specimens of amber containing bark, water and various insects.

After mining, amber is kept temporarily in vaults near the amber localities. Rosa narrates that he entered one of the vaults of the Pächter Douglas, where he saw the yearly products arranged according to their size and quality in chests and baskets, and saw records containing the yearly results back to 1500. The worth of the pieces varies according to the size and perfection.

For the trade it is divided into classes, the best pieces being generally sent in the rough to Constantinople, where they are used for the mouth-pieces of pipes, as it is still believed there that amber possesses properties preventing contagion, and as the pipes of this ease-loving people are lighted by domestics, the amber tips to the long stems are considered a prudent caution. This trade with Constantinople is very ancient and still continues over the same route as a thousand years ago.

The smaller sized pure pieces are used for beads and the very impure for the distillation of succinic acid, the residue or refuse is the *colophonium-succini* employed in the preparation of varnish. The varnish made from amber has long been considered the finest, but other resins are now its rivals, and varied are the secrets of this prosperous trade. With amateurs at work all over the land we may hope that even the secret of Stradivarius may yet come to light!

The chemical analyses of all resins, both fossil and recent, differ very slightly. Certain varieties of amber, copal, mastic, etc., giv-

ing nearly the same atomic ratio as will be seen from the following table:

	Carbon.	Hydrogen.	Oxygen.
Amber	10	8	1
Retinite	12	9	1
Copal	10	9	1
Mastic	10	8	1
Eliminite	10	8	1
Fiehtlite	8	6	1
Ambrite	16	13	1

The conclusion is that their differences consist in the arrangement of their molecules and not in their composition or even age.

Amber may be distinguished from the other resins by its hardness, its lesser brittleness and the much higher temperature required to reduce it, and also its greater electric action, but the difference is quickly discovered in the attempt to cut and polish, as the ordinary resins become in the process so heated and softened as in a measure to prevent their use for ornamental purposes. Copal jewelry is, however, occasionally made, but it soon loses its lustre.

A property of amber not generally known is its flexibility at certain temperatures. Formerly when amber required bending it was softened by placing it in warm linseed oil, and it could then be bent in to a required form. For changing the form of amber the method at present used in our extensive manufactory in this city, is simply to hold the amber over a lamp and draw it out slowly by hand. Although this process is very difficult and slow, the results are marvelous.

A pipe-stem nineteen inches long has been in this way drawn out of a coil of amber about six by four inches in size or fifteen inches in circumference.

At the same factory can be seen all the process of working amber which, owing to its low degree of hardness, is wrought with the turning lathe after having first been cut with a knife and filed into something approaching the form required. It is then polished in the lathe or by hand with pumice stone, whiting and alcohol. The chippings and amber dust left from the cutting are used for varish or incense. The Orientals, especially the Chinese, consider the burning of the odoriferous amber the highest mark of respect possible to pay a stranger or distinguished guest, and the more they burn the more marked is their expression of esteem.

We find in King's work on gems, the following: "A large amber cup, holding half a pint, has lately been discovered deposited in a tumulus in Ireland, which, from its size could hardly have been cut out of a single block of that substance. It has been ascertained by experiment that bits of amber boiled in turpentine can be reduced to a paste, united and molded into any form desired."

In Feuchtwänger on gems, we also find similar assertions regarding the melting and reforming of amber. Both King and Feuchtwänger are in error on this point. If amber were ever thus melted and molded, the art has certainly been lost.

Repeated experiments have failed to produce such a result, although a recent German scientific journal informs us that a patent for such a discovery has been applied for. An art so valuable, if successful, would certainly insure a fortune to the inventor. Nor is it necessary to have recourse to such a theory in order to account for the cup exhumed from the Irish tumulus. Alexander, Czar of all the Russians, owns a tea-set cut from blocks of this precious material. I have seen rough specimens both in the Berlin and Vienna museums larger than would have been required for the cup alluded to.

The imitations of amber are various. Glass paste is sometimes used, another composition is of turpentine and caoutchouc, still another, linseed oil, gum mastic and litharge, to which finely powdered copal is added to give the appearance of veins, add to this, ants of decalcomania, and we have the material of the cigar-holders which so deceived the uninitiated during our exhibition at Philadelphia. The most perfect imitation is the uncolored celluloid. Abbé Haüy gives the following mode of detecting or identifying amber: "Attach a fragment to a knife, and when inflamed the amber will burn with some noise and ebulition, but without liquifying so as to flow, whereas all other resins and compositions melt and drop." A better method is perhaps the electrometer.

Very little amber has as yet been found in the United States. Gay Head, Martha's Vineyard, Camden, N. J., and Cape Sable only are mentioned as its localities. A barrel full of small pieces was taken out of the green sand in New Jersey, which through some mistake was burned.

Let us hope for the accident which may yet reveal to us hidden

stores of this interesting substance with a less primitive fate in reserve for it.

While the color of amber is generally yellow it occurs in all shades, from pure white to "black." The *Falernian*, from the wine of that name, was the favorite color among the Romans. Dice of the white variety are hardly distinguishable from ivory.

At Constantinople a pipe-stem of the milk-white variety is prized by the Turks at from forty to a hundred dollars. The action of sulphuric acid on the yellow changes it to red. A beautiful specimen of green amber has been found on the American coast. "Black amber," which was a vexed question in the middle ages, returns to question us again to-day. Monsieur le Conte de Borch, in his letters from Sicily, within the last decade, says that "black amber is common."

Stretter, the latest English authority on gems, also gives black amber; but a very careful analysis of the black amber which has recently been imported from Spain to be manufactured in New York, gives: Carbon, 82.57; hydrogen, 7.70; oxygen and nitrogen, 9.08; ash, .65. A result so different from true amber, and on distillation yielding no succinic acid, is, therefore, not true amber, but either a superior variety of jet or a highly oxidized bitumen. In chemical composition it seems to occupy an intermediate position between cannel coal and torbanite.

Subjected to the microscope, woody fibre is visible, replaced in part by resin. Its electric power is great, and admitting as it does of a remarkable polish, its lightness well adapts it for ornamental purposes.

Among the old accounts of journeyings in search of amber, we find the first mention of the Teutons as a race. As the search for an "El Dorado" led to voyages of discovery in later times, so we find that voyages and pilgrimages to the land of amber were made dating back to 1500 years before Christ. Peschel says, "Preach aloud the fact that the migrations of nations depend on the existence of the substantial treasures of the earth." So this Prussian paradise had been visited by Pythias of Massilena four hundred years before Christ, also by Theophrastus, the naturalist and philosopher, and by Philomen, the Greek poet. Nero sent there his Roman knights, who brought back quantities of amber to enrich his treasury, and a small image in this precious material was valued higher than a human slave.

Amber was intermingled with the myths and religion of the Greeks, their legends ascribing its origin to

"* * * * the sweet tears shed
By fair Heliades—Apollo's daughters,
When their rash brother down the welkin sped,
Lashing his father's sun team, and fell dead
In Euxine waters."

Amber literature is of great interest to the virtuoso. Books in all languages refer to its many supposed qualities, and the insects contained in it have given rise to many quaint metaphors which still exist. Martial (A. D. 43) wrote in Latin: "The bee is inclosed and shines preserved in a tear of the sisters of Phæton, so it seems enshrined in its own nectar. It has obtained a worthy reward for its great toils—we may suppose that the bee itself would have desired such a death."

Thomas May (1640) thus translates this:

"Here shines a bee, inclosed in an amber tomb,
As if interred in her own honey comb—
A fit reward fate to her labors gave,
No other death would she have wished to have."

Hay in the same century translates it thus:

"The bee inclosed and through the amber shown,
Seems buried in a juice that was her own;
So honored was a life in labor spent,
Such might she wish to have her monument."

Sir John Denham (1640) wrote of streams,

"Whose foam is amber and whose gravel gold."

In the Nibelungen Lied we find Hagentronje with his amber girdle; the dragon's blood armor of Siegfried is also supposed to have been amber; and Brunhilde mentions the amber-colored flower.

Byron alludes to amber in the "Island," and Pope speaking of Sir Plume,

"Of amber snuff-box justly vain."

Also in his prologue to the satires,

"Pretty in amber to observe the forms
Of flies and ants and bees and bugs and worms;
The things we know are neither rich nor rare,
But wonder how the d—l they got there."

Milton apostrophizes a bee in amber, and Moore revels in amber imagery.

Modern authors have written of the weird "amber witch," and of "amber gods," and to-day a lizard in amber is thus addressed:

"Who pinioned thy grotesque and uncouth frame
Within the sunshine of this golden chamber?
Is this the fountain whence the nectar came?
Or is it star born, this undying flame
Which men call amber?

"Splay-footed sprawler from the unknown seas,
Oh, tawny cousin of the Ichthyosaurus—
What sportive sister of Hesperides,
In the ambrosia of celestial trees,
Embalmed thee for us?"

So questions the poet, but if we might invoke this "Ancient Mariner" from out his crystal coffin, more serious would be the questions we would bid him solve.

But though speechless, he bears a silent witness, for as one of the many hieroglyphics of the language of geology, underneath its Rosetta wand, he helps to reveal the history of our earth.

Thrice happy the gifted mortal, who, wielding this magic wand, can lift the veil and translate these mystic symbols of the too long "dusky past."

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EDITORS' TABLE.

EDITORS: A. S. PACKARD, JR., AND E. D. COPE.

—— We recommend to the attention of members of the National Congress who are interested in the intellectual progress of the country, the character of the tariff on specimens, apparatus and books necessary for instruction in the sciences. These objects are only allowed to enter the country free of duty when *not intended for sale.* This practically prohibits any but wealthy citizens and institutions from possessing collections of the natural products of all parts of the earth excepting the United States, a restriction extremely disadvantageous in all directions. The majority of American students are not able to visit Europe for the purpose of making purchases, nor are they able to pay the increased rates which must be demanded by dealers who should bring their specimens here. The result is that foreign collections from all parts of the world pass by our country to go to the various European cities, large and small. This is one of the causes to which we can ascribe the ignorance of natural history which is so general in American Society as compared with that of Germany and some other parts of Europe. The amount of revenue derived from such importations must be practically nothing, while the